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AUTHOR Van Blerkom, Malcolm L.
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ABSTRACT

Psychologists and educators interested in factors that might influence mathematical ability have examined intelligence, motivation, and attitudes toward mathematics. More recently, sex role and cognitive style have entered the picture. The relationships among intelligence, field dependence, sex role, mathematics background, and mathematical ability were investigated in 66 male and 66 female college students. Subjects completed the Embedded Figures Test, the Bem Sex Role Inventory, and the Slosson Intelligence Test. Subjects were also administered a modified version of a mathematics test measuring ability with basic mathematics facts and word problems, ranging from simple addition and subtraction to first-level algebra. Subjects reported all mathematics and related courses taken since ninth grade. Although the number of mathematics courses previously taken and intelligence were found to be the two best predictors of mathematical ability, other variables were found to have indirect contributions. The results revealed that field dependence and sex role indirectly affected mathematical ability by influencing the number of mathematics courses taken. For both males and females, higher scores on the Bem femininity scale were associated with lower scores on the mathematics test and a fewer number of mathematics courses taken. Field-dependent students tended to have taken fewer elected mathematics courses than did field-independent students. These findings suggest that there are personality variables that lead students to avoid mathematics courses. (Author/NB)

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Mathematical Ability in College Students:

A Causal Analysis

Malcolm L. Van Blerkom

Shenango Valley Campus

The Pennsylvania State University

147 Shenango Avenue
Sharon, PA 16146

(412) 981-8662

CG 019032

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Abstract

The relationships among intelligence, field dependence, sex role, mathematics background, and mathematical ability were investigated in this study which used 66 female and 66 male college students. Although the number of mathematics courses previously taken and intelligence were the two best predictors of mathematical ability, other variables were found to have indirect contributions. Structural equations and path analysis revealed that field dependence and sex role affected mathematical ability by influencing the number of mathematics courses taken by high school and college students. This study suggests that there are personality variables that lead students to avoid mathematics courses.

Mathematical Ability in College Students: A Causal Analysis

Malcolm L. Van Blerkom

Shenango Valley Campus
The Pennsylvania State University

Psychologists and educators have been interested in factors that might influence mathematical ability. Factors such as intelligence, motivation, and attitudes towards mathematics have long been suspected to be important. Somewhat more subtly, other factors, such as sex role and cognitive style, have entered the picture.

The field dependent-independent cognitive style has been noted by many researchers to be related to mathematical achievement (DuBois & Cohen, 1970; Satterly, 1976; Viadya & Chansky, 1980; Roberge & Flexer, 1983). The general finding is that field-independent students display superiority in mathematics achievement over field-dependent students. However, Van Blerkom (1985) found that this apparent relationship was inflated because both field dependence and mathematical ability were correlated with intelligence.

Sex related differences in mathematical ability have also been noted by many researchers which lead Maccoby and Jacklin (1974) to conclude that by the onset of adolescence males display a mathematical superiority. However, it is still not certain why these sex related differences occur. Thomas (1985) has suggested that sex differences in high mathematical ability follow a pattern that would allow a genetic interpretation. On the other hand, Sherman (1982, 1983) has suggested that much of the sex related difference in mathematical ability can be accounted for by differential course taking. Van Blerkom (1985) found that perceived sex role, rather than gender, was predictive of mathematical ability.

In general, factors that influence mathematical ability have been examined individually. It was the intent of this study to examine a variety of factors likely to influence mathematical ability using a multivariate framework. It was also intended to attempt to fit the relevant variables into a theoretical causal model.

Method

Subjects

A total of 132 (66 female and 66 male) college students were tested in 1985. The students were enrolled in an introductory psychology course.

Materials

Tests employed in this study were the Embedded Figures Test (Witkin, Oltman, Raskin, & Karp, 1971), the Bem Sex

Role Inventory (Bem, 1974), and the Slosson Intelligence Test (Slosson, 1961). Subjects were also administered a modified version of a mathematics tests designed by Van Blerkom (1985). The math test measured ability with basic math facts and word problems, ranging from simple addition and subtraction to first-level algebra. In addition, subjects were requested to report all mathematics and related courses taken since ninth grade.

Procedure

Each of the 132 subjects was tested individually. Each part of the math test was timed in order to allow approximately 80% of the subjects to complete all of the items.

Results

The first step in the data analysis was an examination of the correlation matrix (Table 1). Knowledge of basic math facts appeared to be essentially unrelated to any of the predictor variables which may have been due to a ceiling effect. In general, subjects did very well on this test. The ability to do word problems, however, was significantly correlated with intelligence, $r = .48$, $p < .0001$; number of mathematics courses previously taken, $r = .38$, $p < .001$; and the femininity scale on the Bem, $r = -.31$, $p < .001$.

It is also important to note that several of the predictor variables were significantly correlated with the number of mathematics courses which had been previously taken, itself a predictor variable. These variables were the Embedded Figures Test, $r = -.32$, $p < .001$; the femininity scale from the Bem, $r = -.30$, $p < .001$; and the Slosson Intelligence Test, $r = .28$, $p < .01$.

The relationships among the predictor variables and math ability were complex. Therefore, a path analysis was performed in order to try to establish theoretical causal links.

The path analysis required several assumptions. Although intelligence and field dependence were measured concurrently with the other variables, it was assumed that they each represented fairly stable traits. That is, it was assumed that the scores college students received on these variables would correlate highly with scores that the students would have received on these tests while in high school (Witkin, Goodenough, & Karp, 1967).

The results of the path analysis can be found in Figure 1. Inspection of the path model clearly showed that the predictor vabiables often affected math ability in both direct and indirect ways. For example, femininity (as defined by the Bem) was not only directly related to math ability in college students, but it was also indirectly related in that it influenced how many math courses students

elected to take. Intelligence played a similar role in both directly and indirectly influencing math scores. Field dependence played its greatest role through the indirect route.

Discussion

These data suggest that factors which affect mathematical ability often do so both directly and indirectly. For example, students who scored high in femininity did less well on tests of math ability, but also elected to take fewer math courses. Thus, in the long run the disparity in math ability tended to increase. In this study, the direct and indirect influences on math scores were found to be the case not only for the entire sample, but also for the sub-samples of males and females. Higher scores on the Bem femininity scale were associated with lower scores on the math test and a fewer number of math courses taken.

In a similar vein, field dependence also appeared to have affected math ability. However, in this study its greatest influence was on the number of math courses taken. Field-dependent students tended to have taken fewer elected math courses in high school and college than did field-independent students.

This study suggests that there are certain personality and cognitive factors that lead students to avoid taking math courses in high school and college. Of course, these students may be taking fewer math courses because they have not experienced success in mathematics. However, math avoidance can only lead to greater difficulties in mathematics in the future (e.g. college). Educators must work to, first, have these students experience greater success in mathematics in elementary and junior high school, and, second, make math courses more attractive to them in high school. When planning math courses it is important to consider the the affective domain. Math courses should leave students with positive attitudes about both themselves and mathematics. Finally, high school and college students should be encouraged to take more math courses.

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Table 1

Correlation Matrix for Predictor and Criterion Variables

Variables	2	3	4	5	6	7
1. EFT	.10	-.20[1]	-.19[1]	-.32[3]	-.02	-.14
2. Bem (Fem.)		.18[1]	-.13	-.30[3]	-.13	-.31[3]
3. Bem (Masc.)			.02	.02	-.08	-.08
4. Slosson				.28[2]	.13	.48[3]
5. Math Background					.15	.38[3]
6. Math Facts						.39[3]
7. Word Problems						

[1] $p < .05$

[2] $p < .01$

[3] $p < .001$

Figure 1

Patn Analysis Predicting Word Problem Scores